Substitute Specification:

- -METHOD FOR CONTROLLING HANDOVER OF TELECOMMUNICATIONS CONNECTIONS BETWEEN MOBILE PARTS AND BASE STATIONS IN CELLULAR TELECOMMUNICATIONS SYSTEMS

BACKGROUND OF THE INVENTION

Field of the Invention

In general, the present invention pertains to the field of wireless telecommunications. In particular, the present invention pertains to wireless telecommunication system handover controls.

Discussion of the Related Art

Telecommunications systems using wireless telecommunication between mobile and/or stationary transmitting/receiving appliances are specific message systems with a message transmission path between a message source and a message sink. In these systems, base stations and mobile parts are used as transmitting and receiving appliances for processing and transmitting messages in which the message processing and message transmission can be carried out in a preferred transmission direction (simplex operation) or in both transmission directions (duplex operation), the message processing is preferably digital and messages are transmitted via a long-distance transmission path without using wires.

The message processing and transmission is based on various message transmission methods to allow for multiple use of message transmission pats, such as FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access) or CDMA (Code Division Multiple Access). For instance, in accordance with standards such as DECT Digital Enhanced Cordless Telecommunication, as discussed in Nachrichtentechnik Elektronik [Information Technology, Electronics] 42 (1992) Jan/Feb, No. 1, Berlin, Germany, or in U. Pilger "Struktur des DECT-Standards" [Structure of the DECT Standard], pages 23 to 29 in conjunction with ETSI Publication ETS 3001750-1 October 9, 1992 and the DECT Publication from the DECT Forum, February 1997, pages 1 to 16], GSM [Groupe Special Mobile or Global System for Mobile Communication. See also, Informatik Spektrum [Information Technology Spectrum] 14 (1991) June, No. 3, Berlin, DE; A. Mann: "Der GSM-Standard - Grundlage für digitale europäische Mobilfunknetze", [The GSM Standard - Basis for Digital European Mobile Radio Networks, pages 137 to 152 in conjunction with the publication Telekom Praxis, April 1993, P. Smolka "GSM-Funkschnittstelie - Element und Funktionen", [GSM radio interface - Elements and functions], pages 17 to 24, UMTS [Universal Mobile Telecommunication System. Further discussion is provided by Nachrichtentechnik Eiektronik, [Information Technology Electronics], Berlin 45, 1995, Issue 1, pages 10 to 14 and Issue 2, pages 24 to 27, and

by P. Jung, B. Steiner: “Konzept eines CDMA-Mobiifunk-systems mit gemeinsamer Detektion Für Die Dritte Mobiifunk-generation” [Concept of a CDMA Mobile Radio System with Joint Detection for Third Generation Mobile Radio], and by Nachrichtentechnik Eiektronik, [Information Technology, Electronics], Berlin 41, 1991, Issue 6, pages 223 to 227 and page 234; P.W. Baier, P. Jung, A. Klein: “CDMA - ein günstiges Vieifachzugriffsverfahren für frequenzselek tive und zeitvariante Mobilfunkkanäle”; [CDMA - A Useful Multiple Access Method For Frequency-Selective and Time-Variant Mobile Radio Channels]. Further discussion is given in IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences, Vol. E79-A, No. 12, December 1996, pages 1930 to 1937, and P.W. Baier, P. Jung: “CDMA Myths and Realities Revisited”, and IEEE Personal Communications, February 1995, pages 38 to 47. Aslo see, A. Urie, M. Streeton, C. Mourot: “An Advanced TDMA Mobile Access System for UMTS”, Telekom Praxis, 5/1995, pages 9 to 14; P.W. Baier: “Spread-SpectrumTechnik und CDMA - eine ursprünglich militärische Technik erobert den zivilen Bereich” [Spread Spectrum Technology and CDMA - An Originally Military Technology Wins Over the Civil Area], and in IEEE Personal Communications, February 1995, pages 48 to 53, in P.G. Andermo, L.M. Ewe rbring: “An CDMA - Based Radio Access Design for UMTS”, in ITO Fachberichte [Specialist Report] 124 (1993), Berlin, Offenbach: VDE Verlag ISBN 3-8007-1965-7,

pages 67 to 75, and in Dr. T. Zimmermann, Siemens AG: "Anwendung von CDMA in der Mobilkommunikation" [Use of CDMA in Mobile Communication]. Also see, Telecom Report 16, (1993), Issue 1, pages 38 to 41, a paper by Dr T. Ketseoglou, Siemens AG and Dr. T. Zimmermann, Siemens AG: "Effizienter Teilnehmerzugriff für die 3rd Generation der Mobilkommunikation - Vielfachzugriffsverfahren CDMA macht Luftschnittstelle flexibler"; [Efficient Subscriber Access for 3rd Generation Mobile Communication - The CDMA Multiple Access Method Makes the Air Interface More Flexible], and Funkschau 6/98: R. Sietmann "Ringen um die UMTSSchnittstelle" [Ringing Round the UMTS Interface], pages 76 to 81] WACS or PACS, IS-54, IS—95, PHS, PDC etc., as well as IEEE Communications Magazine, January 1995, pages 50 to 57, and D.D. Falconer et al: "Time Division Multiple Access Methods for Wireless Personal Communications."

The word message is a generic term which covers not only the information content but also the physical representation of its signal. Despite a message having the same information content, different signal forms may occur. Thus, a message relating to one item can be transmitted in the form of an image, as spoken word, as written word, or as an encrypted word or image.

Transmission types are normally characterized as continuous (analog) signals, while discontinuous signals, although pulses, digital signals may also be used.

In telecommunications systems of the type mentioned above, the handover of an ongoing call or connection is a highly time-critical process, since the continuity of ongoing connections must be ensured. In particular, a distinction is often required between an intracell handover, an intercell handover and an external handover.

In order to carry out a handover between a mobile transmitting/ receiving appliance, such as a mobile station or a mobile part connected to a stationary transmitting/receiving appliance, and a base station or a fixed part in a cell, cell-specific information about the adjacent cell, or about a number of adjacent cells is required. The method used to receive this information is referred to as monitoring, wherein the mobile station monitors a control channel, the so-called Broadcast Control CHannel (BCCH) on which the cell-specific information is broadcast by the base station.

One problem with this method relates to how the mobile station obtains the required cell-specific information and the current parameters, such as, frequency, timeslot, and the code of the adjacent base station to which the connection is intended to be transferred by the handover procedure and to which the handover is then intended to be made, when

the mobile station is in an uncoordinated, unlicensed scenario. Such a scenerio involves an arrangement where there are a large number of unsynchronized residential base stations, or in a purely coordinated, licensed cellular scenario, say in the case of a TDD-UMTS system, the scenario involves virtually all the physical channels occupied by data traffic which makes it almost impossible to receive the Broadcast Control CHannel of the adjacent base stations due to high data rates encountered.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for telecommunications connections to be handed off from uncoordinated, unlicenced operation to coordinated, licensed operation.

It is another object of the invention to provide a method for initial monitoring in a base station supporting uncoordinated, unlicensed system operation.

It is an additional object of the invention to provide a method to carry-out a time-critical handover from indoor to outdoor.

It is a further object of the invention to provide a method for initial monitoring where high asymmetric data rates are used.

These and other objects of the invention will become apparent upon careful review of the following disclosure, which is to be read in conjunction with review of the accompanying drawing figure.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a universal mobile telecommunications network;

Figure 2 shows a modified universal mobile telecommunications network;

Figure 3 shows a mobile station according to the present invention;

Figure 4 shows another mobile station according to the present invention; and

Figure 5 shows another mobile station according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 shows one possible UMTS scenario (Universal Mobile Telecommunication System) with a multicell universal mobile telecommunications system. UMTS operates using both the uncoordinated, unlicensed system mode and the coordinated, licensed system mode.

The UMTS system shown in Figure 1 has a first telecommunications subsystem TKTSI which operates in first radio cells FZI using wireless telecommunication between a first base station BS1, in the form of an indoor base station, and n mobile stations, MS1... . Msn. The mobile stations, MS1 ... MSn are preferably in the form of indoor/outdoor mobile stations, and are operated in the uncoordinated, unlicensed system mode. The UMTS system has a second

telecommunications subsystem TKST2, which operates in second radio cells FZ2, using wireless telecommunication between a second base station BS2, which is also in the form of an outdoor base station, and m second mobile stations Msn+1 . . . Msn+m. The base stations, Msn+1 . . . Msn+m, are preferably in the form of indoor/outdoor mobile stations, and are operated in the coordinated, licensed system mode.

A mobile assisted handover is carried out in the known GSM scenario. Monitoring is carried out by the mobile station during the free timeslots. That is to say, when the mobile station autonomously receives the BCCH of the adjacent base stations. The mobile station selects that base station whose reception quality is the best, and signals this to its own base station. The handover in this case is initiated by the mobile station and is controlled by the base station. This is referred to as a mobile assisted handover. A critical factor in this case is for the mobile station to have already received advance information from the network operator, and on its active BCCH on the frequencies to be searched in the adjacent base stations.

In contrast to the GSM scenario, a mobile initiated and mobile controlled handover is carried out according to the DECT scenario. Monitoring is in this case carried out by the mobile station, and the handover is likewise controlled by the mobile station. The mobile station in this case has no advance information about which channels, i.e. which

frequencies/timeslots - must be looked for during monitoring for the Broadcast Control CHannels of the adjacent cells. The BCCH, according to the DECT terminology, correspond to the channels in which dummy bearer information is transmitted.

A mobile assisted handover is likewise planned, as for the GMS scenario, for the cellular UMTS scenario, which is currently subject to standardization. The monitoring is carried out by the mobile part, and the handover is initiated by the mobile station and is controlled by the base station. It is highly probable that advance information from the network operator will also be required in this case about which channels [lacuna] (these are essentially the codes, since the frequency reuse is unity).

In all the scenarios mentioned above, the monitoring is carried out by means of the mobile station.

The problem of initial monitoring ,such as information about channels on which the Broadcast Control Channel of the adjacent cells can be received, has until now been solved in the cellular field by means of advance information provided in advance by the network operator and intended for the respective mobile station, with this advance information having been transmitted to the relevant mobile station by the active base station using the Broadcast Control CHannel. The only exception is the DECT scenario, since, in this case, there is no need for initial monitoring for the coordinated, licensed mode. It is thus necessary during cellular

DECT operation for the mobile station to continuously scan adjacent frequencies looking for the Broadcast Control CHannel for an intercell handover. However, with respect to standby times, this is not an optimum solution with respect to asymmetric data services and allocation of a number of timeslots. In uncoordinated DECT operation, only an intracell handover is possible, so that there is no need for initial monitoring.

In the past, no handover has existed from uncoordinated, unlicensed system operation to coordinated, licensed system operation such as residential TDD—UMTS system to the public FDD-UMTS or public TDD-UMTS system.

The idea on which the invention is based is to carry out the initial monitoring problem, mentioned initially, in the first base station which supports uncoordinated, unlicensed system operation.

This method offers the advantage that the BCCH search by the first base station, which supports uncoordinated, unlicensed system operation and has no a priori knowledge about the conditions in the adjacent cells, need be carried out only once by base stations arranged in the adjacent cells, when the appliance is switched on, and then may be carried out once again only at relatively long periodic intervals. This information is then signaled, such as using the BCCH to the mobile part or to the mobile station.

Fundamentally, the advantages for the mobile station are reduced power consumption, an increase in the standby time, the fact that the initial monitoring is carried out by the first base station, and reduced complexity in the case of pure residential mobile stations or indoor terminals. In addition, the complexity is integrated in the first base station.

Since the first base station receives cell specific information about the adjacent public cells only as a result of the initial monitoring (and, particularly for UMTS, a highly time-consuming computation process is required in order to detect a cell—specific scrambling code without advance information) a dual mode mobile station designed for indoor/ outdoor purposes is for the first time able to carry out a particularly time-critical handover from indoor to outdoor.

The essential idea is for the monitoring to be carried out in the outdoor and indoor base station. Where high asymmetric data rates are used with TDD mode operation, this procedure offers advantages both for indoor to outdoor handover and for the intracell handover. Monitoring in the first base station can be used to provide an asymmetric service with a high downlink data rate and a low uplink data rate, and vice versa.

Monitoring in the first base station can also be used to provide interference measurement on another carrier frequency and, if required, to hand over the entire asymmetric connection to the other carrier frequency.

This is known as interfrequency handover. An indoor to outdoor handover while maintaining the high data rate is likewise possible.

If the monitoring functionality is integrated in the base station and in the mobile station, then an asymmetric service with a low downlink data rate and a high uplink data rate can be handed over from one carrier frequency to a carrier. In this situation, the monitoring cannot be carried out by the base station since virtually all the timeslots are used for reception in this case, and the monitoring is in this case carried out by the mobile station.

An exemplary embodiment of the invention will be explained with reference to Figures 2 to 7.

Based on the UMTS scenario, shown in Figure 1, the telecommunication system will operate both in the uncoordinated, unlicensed system mode and in the coordinated, licensed system mode.

Specifically, Figure 2 shows a modified UMTS scenario with initial monitoring. The first base station BS1 and the first mobile stations MS1 . . . Msn, as in the UMTS scenario in Figure 1, are located in the first radio cell FZ1.

Adjacency occurs when associated radio cells, such as the first radio cell FZ1 and the second radio cell FZ2, are adjacent to one another or overlap. As shown in figure 2, the second base station BSZ, which is located in the second radio cell FZ2, which completely covers the first

radio cell FZ1 with the first base station BS1, and, secondly, further second base stations BS1.1. . .BS1.6 which, although they are in the form of first base stations BS1 are referred to as further second base stations BS2 owing to their adjacency to the first base station BS1 in the first radio cell FZ1. Second base stations BS1.1 . . . BS1.6 are arranged in further second radio cells FZ1.1 . . . FZ1.6, which are immediately adjacent to the first radio cell FZ1 with the first base station BS1, and are in the form of a first radio cell FZ1 but are referred to as further second radio cells FZZ owing to the adjacency to the first radio cell FZ1 with the first base station BS1.

For the initial monitoring, the first base station BS1, which supports uncoordinated, unlicensed system operation and is associated with the first cell, FZ1, in a first monitoring mode receives messages which are relevant for handing off telecommunications connections and which are transmitted by at least one of the second base stations BSZ, BS1.1 . . . BS1.6 which are adjacent to the first base station BS1, support coordinated, licensed system operation or uncoordinated, unlicensed system operation and are each associated with the second cell FZ2, FZ1.1 . . . FZ1.6. In each case one first telecommunications channel which is in the form of the BCCH.

After this, the first base station BS1 assesses the information content and reception quality of the received messages and transmits a

list, organized on the basis of the reception quality, of parameters which are required for handing over the telecommunications connection each associated with each one of the second base stations BSZ, BS1.1 . . . BS1.6, on a second telecommunications channel which is in the form of the BCCH, to the first mobile stations MS1 . . . MSn which are located in the first cell FZ1.

Figures 3 to 7 each show a timeslot representation with eight timeslots ZS1 . . . Z58 to show the monitoring scenario for the base stations BS1, BSZ, BS1.1 . . . BS1.6 and the mobile stations MS1 . . . MSn, MSn+1. . . MSn+m. The base stations BS1, BSZ, BS1.1 . . . BS1.6 use a first timeslot ZS1 as the BCCH, and that there is a bidirectional, asymmetric data link at a first frequency fi in each case between the base stations BS1, BSZ, BS1.1. . .BS1.6 and the mobile stations MS1.. .MSn, MSn+1. . .MSn+m, said data link in each case having a number of reception timeslots RxI and transmission timeslots TxI and in each case extending over at least the timeslots ZS2 . . . ZS6. Furthermore, the expression M(f2), M(f3) in each case indicates that the base stations BS1, BS2, BS1.1 . . . BS1.6 and/or the mobile stations MS1 . . . MSn, Msn+1 . . . MSn+m carry out monitoring M on a second frequency fZ or on a third frequency f3.

Figure 3 shows that the mobile station MS1.. .MSn, Msn+1 . . . MSn+m maintains a bidirectional, asymmetric data link with the reception

timeslots RxI and transmission timeslots TxI in the timeslots ZS1 . . . ZS6 with the base station BS1, BSZ, BS1.1 . . . BS1.6, that the base station BS1, BSZ, BS1.1 . . . BS1.6 maintains a further bidirectional data link to another mobile station in the timeslots ZS7, ZS8, and that the mobile station MS1 . . . MSn, MSn+1. . . MSn+m initiates a second monitoring mode, for handing off information which is relevant to telecommunications networks, by monitoring M, for example, on the second frequency fZ in the timeslots ZS7, ZS8, in order to transmit the asymmetric data link at a maximum data transmission rate, which can be predetermined, in the downlink direction and at a minimum data transmission rate, which can be predetermined, in the uplink direction via the base stations BS1.1. . . BS1.6.

Figure 4 shows that the mobile station MS1 . . . MSn, Msn+1 . . . MSn+m maintains a bidirectional, asymmetric data link with the reception timeslots RxI and transmission timeslots TxI in the timeslots ZS1... ZS6 with the base station BS1, BSZ, BS1.1 . . . BS1.6, that the mobile station MS1. . .MSn, MSn+1. . .MSn+m initiates the second monitoring mode for handing off information which is relevant for telecommunications connections by monitoring M. On the third frequency f3 in the timeslots ZS7, ZS8, in order to transmit the asymmetric data link at a maximum data transmission rate, which can be predetermined, in the downlink direction and at a minimum data transmission rate, which can be predetermined, in

the uplink direction via the base station BS1, BSZ, BS1.1 . . . BS1.6, and that the base station BS1, BSZ, BS1.1 . . . BS1.6 initiates the second monitoring mode for handing off information which is relevant for telecommunications connections by monitoring M. On the second frequency fZ in the timeslots ZS7, ZS8, in order to transmit the asymmetric data link at a maximum data transmission rate, which can be predetermined, in the downlink direction and at a minimum data transmission rate, which can be predetermined, in the uplink direction via the base station BS1, BS2, BS1.1 . . . BS1.6.

Figure 5 shows that the mobile station MS1 . . . MSn, Msn+1 . . . MSn+m maintains a bidirectional asymmetric data link with the reception timeslots 3x1 and transmission timeslots Txl in the timeslots ZS1 . . . Z57 with the base station BS1, BSZ, BS1.1 . . . BS1.6, and that the base station BS1, BSZ, BS1.1 . . . BS1.6 initiates the second monitoring mode for handing off information which is relevant to telecommunications connections by monitoring M. On the second frequency fZ in the timeslot ZS8, in order to transmit the asymmetric data link at a maximum data transmission rate, which can be predetermined, in the downlink direction and at a minimum data transmission rate, which can be predetermined, in the uplink direction via the base station BS1, BSZ, BS1.1 . . . BS1.6.

Figure 6 shows that the mobile station MS1 . . . MSn, MSn+1. . .MSn+m maintains a bidirectional asymmetric data link with the reception

timeslots RxI and transmission timeslots TxI in the timeslots ZS1 . . . ZS7 with the base station BS1, BSZ, BS1.1 . . . BS1.6, and that the base station BS1, BSZ, BS1.1 . . . BS1.6 initiates the second monitoring mode for handing off information which is relevant to telecommunications connec-tions by monitoring M. On the second frequency f2 in the timeslot ZS8, in order to transmit the asymmetric data link at a minimum data transmission rate, which can be predetermined, in the downlink direction and at a maximum data transmission rate, which can be predetermined, in the uplink direction via the base station BS1, BSZ, BS1.1 . . . BS1.6.

Figure 7 shows that the mobile station MS1. . .MSn, Msn+1 . . . MSn+m maintains a bidirectional, asymmetric data link with the reception timeslots 3x1 and transmission timeslots TxI in the timeslots ZS1 . . . ZS7 with the base station BS1, BS2, BS1.1 . . . BS1.6, that the mobile station MS1. . .MSn, MSn+1. . .MSn+m initiates the second monitoring mode for handing off information which is relevant to telecommunications connec-tions by monitoring M. On the third frequency f3 in the timeslot ZS8, in order to transmit the asymmetric data link at a minimum data transmission rate, which can be predetermined, in the downlink direction and at a maximum data transmission rate, which can be predetermined, in the uplink direction via the base station BS1, BSZ, BS1.1 . . . BS1.6, and that the base station BS1.1 . . . BS1.6 initiates the second monitoring mode for handing off information which is relevant to telecommunications

connection by monitoring M. On the second frequency f2 in the timeslot ZS8, in order to transmit the asymmetric data link at a minimum data transmission rate, which can be predetermined, in the downlink direction and at a maximum data transmission rate, which can be predetermined, in the uplink direction via the base station BS1.1 . . . BS1.6.

Although preferred embodiments of the invention have been described herein, it is to be understood that the invention is not limited to these embodiments, and that various changes and modifications thereto may be made without departing from the scope or spirit of the invention, which is defines by the following claims. - -